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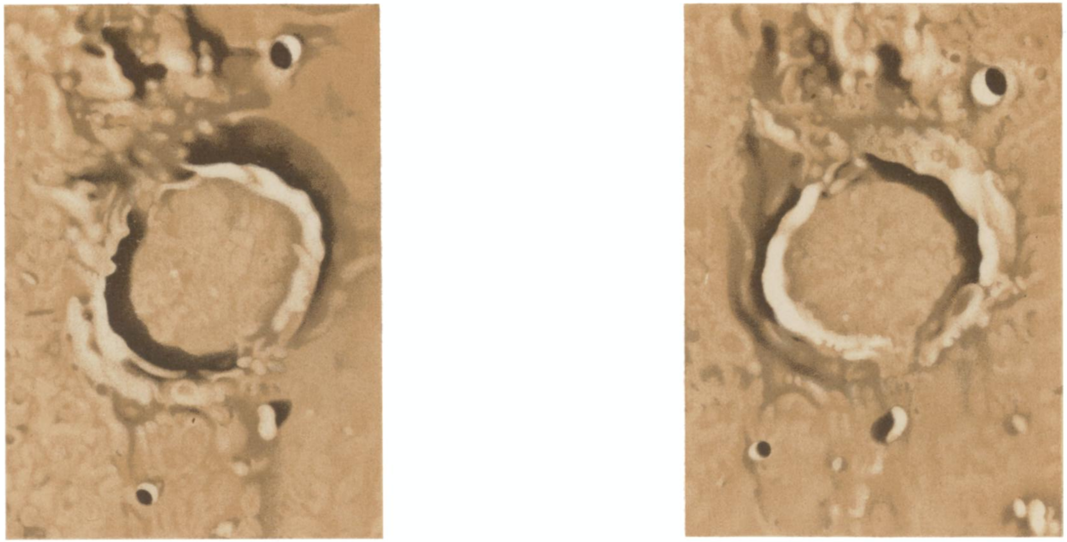

ARCHIMEDES

drawn by Professor Dr. L. Weinek, from negatives taken in the focus of the 36-inch refractor of the Lick Observatory, August 15 and 27, 1888.

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# ENLARGED DRAWINGS FROM LUNAR PHOTOGRAPHS TAKEN AT THE LICK OBSERVATORY.

BY PROF. DR. L. WEINEK OF PRAGUE.*

In November, 1889, Professor EDWARD S. HOLDEN kindly made the proposition to me that he would send to Prague a series of the best negatives of the moon, taken with the 36-inch refractor of the Lick Observatory, in order that they might serve as a basis for my drawings of lunar craters and lunar landscapes made at the telescope, as well as to furnish subjects for special studies of the moon's surface. I was all the more eager to entertain such a proposition, because the Prague Observatory is possessed of only a six-inch telescope on a very inconvenient mounting, and because the opportunity was offered to take part in the magnificent results of the—at present—largest instrument in the world.

Up to this time I had made fifty-four lunar drawings at the telescope, and I was justified, by reason of considerable practice of eye and hand, in taking up this new labor.

Since the beginning of the year 1890, Professor HOLDEN has sent to Prague continuously a large number of plates for the different days of a lunation, and I am greatly indebted to him for creating an incentive to do this work, as well as for the valuable donation of these beautiful plates to the Prague Observatory from the Lick Observatory.

For the purpose in view I had built at Dresden a suitable apparatus before beginning the task. In this the photographic plate is viewed by transmitted light by means of two eye-pieces of 41.15 and 25.20 millimetres (equivalent) focus. (Linear enlargement = 7.8 and 12.1 for my distinct vision of 28 centim.) The holder or stand of the eye-pieces possessed a double motion in two co-ordinate directions normal to each other; it admitted of a ready and rapid adjustment of the portion of the moon viewed, and kept the chosen lens at a constant distance from the plate. The illumination of the latter may be obtained by daylight or by means of a lamp; in the case of the former a parabolic reflector may be so set or turned as to furnish the desired degree of light. For drawing, diffused daylight is used, by inserting a dull ground glass between the plate and the reflecting mirror. The window at the left hand of the draughtsman throws light at the same time on the small drawing-board which holds the paper. A handy little drawing-table attached to the lower part of the apparatus, completes the outfit. That the person engaged in viewing or drawing may not become too easily fatigued, the plate with the mirror may be turned backward and set at will to any desired angle. The apparatus is arranged for large plates as well as for very small ones.

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* Translated for the Society by OTTO VON GELDERN, Esq.

Since every direct photographic enlargement presents numerous defects, and will be found inferior to the original, particularly in strength and intensity, it was not a superfluous undertaking to prepare enlarged drawings or tintings from the original plates—drawings that were to be made in this case with the greatest exactness and absolute truth as to strength and clearness—for the reason, that work done in this manner may be continued at any time, and can be constantly controlled and improved upon.

In this particular *two* methods were available; the first, by having very faint photographic enlargements of certain particularly interesting portions of the lunar surface thrown upon suitable paper and by retouching them subsequently to the fullest intensity of the original; and the second, by discarding the photographic aid altogether and projecting a mathematically accurate enlargement to any desired scale, by means of suitable instruments, directly upon the best white drawing-paper, upon which the representation is then newly developed and entirely built up.

In the first or photographic method, which I used in making a four-fold enlargement of the *Mare Crisium*, from *Apollonius* in the south to *Geminus* in the north, taken from the beautiful Lick-exposure of August 23d, 1888, a work requiring 34¾ hours, I found it very unfavorable that the so-called salt paper (salz-papier), which is commonly in use in photographing coloring, is of so hygroscopic a nature that it requires the most careful and painstaking drying at a considerable expense of time; and again I have found that every photographic paper will lose in whiteness by reason of the chemical process it has to undergo, and in consequence will not admit of showing the lighter portions of the moon with sufficient brightness. It was principally for the latter reason that I soon adopted the second method. Since an exact tracing of contours was unavoidable, and having found that even the most transparent papers with millimetre graduations were unsatisfactory, I had glass scales made containing precise divisions into square millimetres. These as well as the above described drawing apparatus were made by the mechanician HEYDE of Dresden, who after a few trials succeeded in etching these scales. Such a scale is now laid, with its etched side down, upon the plate and held there by means of two springs at opposite ends; that part of the lunar surface which it is desired to enlarge is followed in the smaller squares on the glass, and reproduced in similar squares previously drawn on the paper to any required degree of enlargement. In this manner the originals of the two lithographic copies accompanying this paper, of the magnificent ring-plain of *Archimedes* were drawn, magnified ten times.

The picture on the left belongs to the Lick-exposure of August 15th, 1888 (age of the moon eight days), and required for its final and finished completion in tints 44¾ working hours, while the one on the right is from an exposure taken at the Lick Observatory on the 27th of August, 1888 (age of the moon twenty days), and required a working-time of 43 hours. Each is of a size of five by seven centimetres.

Let us now proceed to the scientific discussion of these drawings. In what follows the one on the left will be designated I, that on the right II.

At first glance it is recognized, that *Archimedes* appears somewhat larger on I than on II, although both drawings were magnified from the originals exactly ten times. From this it must be concluded that the lunar diameter of the photograph taken on the 15th of August, 1888, must have been larger than on the one taken August 27th, 1888. And indeed we find that, measuring in the line of the zero meridian (direction from the eastern wall of *Autolycus* to the west wall of *Ptolemy*) the diameter is 130.0 millimetres for the first named plate, while for the second it is only 119.7 millimetres. This is further explained by the fact that I was taken near the time of the moon's perigee (which took place on August 14th at $0^h$ Greenwich mean time) whereas II was obtained near the apogee of the moon (occurring on August 28th at 1$^h$ Greenwich mean time). If for an approximation the corrections for refraction, parallax and libration be left unconsidered, the arithmetical mean of the dimensions of I and II may be looked upon as that corresponding to the mean distance of the moon from the earth, which, as well known, was used in the large lunar charts of one metre by LOHRMAN and MÄDLER, and the 2-metre chart made by SCHMIDT. Since the latter is based upon observations extending through a period of over thirty years, and is the most detailed, let us adopt it for the purpose of making our comparisons. *Archimedes* is shown upon section IV of the same. As far as the effects of libration are specially concerned, a simple reflection will show that on account of the juxtaposition of *Archimedes* to the central meridian, it is principally the libration in latitude that need be considered. Since the centre of the moon was 4° above the ecliptic on the 15th of August, and on the 27th 5° below it, the first exposure would necessarily show more of the southerly portions, and the second more of the northerly parts of the lunar surface. But since *Archimedes* is situated in about 30° selenographic latitude in the northern hemisphere, it follows that this walled-plain must lie nearer to the visible edge of the moon on I than upon II, which is confirmed by comparing the two photographs. For this reason the meridional dimensions of I must appear perspectively shortened and those of II perspectively lengthened, when compared with those that occur under a mean geocentric libration in latitude (the moon's centre being in the ecliptic); and in our case this must be so in nearly equal amounts, so that, roughly approximated, we may consider the mean of I and II as free from all libratory effects.

In order to make this subject intelligible to the reader without the aid of a contour drawing from I or II, and without adopting a nomenclature of figures or letters for the numerous objects of each picture; and in order to permit a most careful comparison with SCHMIDT'S chart, it will be well to characterize the single objects by means of polar-co-ordinates referred to some easily determined initial point. As such the centre of the ring-plain might be taken, provided that its periphery would prove sufficiently regular for the purpose. But this is not the case. I have therefore joined the centres of the two craters, located southeast and northwest from *Archimedes* respectively, crater A (shown in the picture in the upper right hand corner) and C (at the lower left hand), by drawing a straight line from one to the other; this line was bisected, and the point of bisection, which is nearly in the middle of *Archimedes*, was adopted as the initial point (O) of the co-ordinates. By the projection of this line A O C, as well as by drawing the lunar meridian passing through O upon SCHMIDT'S chart, the angle between the line OA and the direction O-South was found to be 51°. This angle properly laid off from AC on I and II, determines upon each picture the position of the meridian through O, and defines thus the cardinal points, north, south, east and west for the presented landscape. If furthermore the angle between O-North and O-Object, measured from the north around to the east, be called the position angle (*p*) of the object, the location of the latter will be absolutely fixed by this angle and the linear distance (*d*) of the object from O. It is also to be noted that when the lunar meridian is traced upon both pictures, it is found that this line appears upon II as though it were turned 15° towards the east in the upper part; this corresponds to the position of the line of the limit of light to the vertical edge of the plate in the exposures. The latter direction, however, was the necessary guide for the orientation of the enlarged drawing.

By comparing the distance AC upon I and II with the same distance upon SCHMIDT'S chart, we obtain at once the scale of my ten-fold enlargements, presuming that it is correctly given on the former. SCHMIDT gives AC = 83.5 (MÄDLER 43.0), on I it equals 61.0 and on II 57.0 millimetres. Since it is necessary to take the average of I and II, in order to reduce the moon to mean distance, the dimensions of the mean of both drawings are smaller than SCHMIDT'S in the proportion of 59.0 to 83.5. Every linear value of SCHMIDT'S chart therefore, if multiplied by 0.7 will give very nearly the corresponding dimensions in the scale of my enlargements. It follows that I and II correspond to a lunar chart having a diameter of 1.4 metres, which is nearly a mean between that of MÄDLER and that of SCHMIDT. Since on the latter $1^{mm} = 0''.95687 = 1.7832$ kilometres, it is seen that upon I and II $1^{mm} = 1''.367 = 2.547$ kilometres. A proof of this relation between linear and angular measure may likewise be deduced from the photographic focus of the Lick refractor. This taken at 570.2 inches = 14.48295 metres, will make the angle corresponding to one millimetre on the plate equal to 14.2419 seconds of arc, and increasing ten times, $1^{mm}$ becomes equal to $1''.4242$. We may therefore accept that $1^{mm} = 1''.4$.

In the following table the most notable objects upon I and II have been identified with SCHMIDT'S map by taking off their position angles and distances. In order to enable one to compare the latter with each other, the dimensions from the SCHMIDT chart are multiplied by 0.7, those of I by $\frac{59}{61}$ and those of II by $\frac{59}{57}$, and the values so obtained have been noted as reduced distances. That which has been found at variance with SCHMIDT may be seen in the annotations to each object at the foot of the table.

In order to obviate any misunderstanding, however, something must be said regarding the lithographic reproduction, which has been carried out in five different shades. Although this method may represent the drawings in a general way, it must be said that in the matter of the blending and in the finer degrees of shading a true copy can not be obtained. The mechanical process of a five-fold imprint from five different stones, which was found requisite to produce the numerous soft gradations, is alone sufficient to cause many faults, not considering those to which the lithographer himself is liable in making five different drawings of the varying tones of the same copy. It may be remarked that on the first proof there were discovered about fifty errors to each picture, and that the second proof, after reducing the requirements as much as possible, still showed about twenty-five errors to each. It had to be acknowledged at last that this work, if it is to be fairly true to the original, lies beyond the capabilities of lithography.

For this reason these *Archimedean* views with other drawings have since been transmitted for heliographic reproduction. It is only after their publication in heliogravure, which will appear in the annals of the Lick as well as the Prague Observatory, that a fair judgment can be formed of the accuracy and truth of the originals, and of the care bestowed upon their production.

The individual objects are given in the following table:

TABLE OF OBJECTS.—ARCHIMEDES.

| Quadrant. | Object Number. | Schmidt. | | I. | | II. | | Sch. | I. | II. | GENERAL DESCRIPTION AND POSITION OF OBJECTS. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *p* | *d* | *p* | *d* | *p* | *d* | Reduced *d* | | | |
| | | ° | mm. | ° | mm. | ° | mm. | mm. | mm. | mm. | |
| N. E. | 1 | 7 | 43.5 | 6½ | 27.1 | 5 | 25.5 | 30.4 | 26.2 | 26.4 | small crater northeasterly of mountain E. |
| | 2 | .... | .... | ....... | .... | 14–61 | 11–12 | .... | .... | .... | northeast wall on interior. |
| | 3 | .... | .... | 70 | 12.0 | ..... | ..... | .... | 11.8 | .... | inner boundary of N. E. wall. |
| S. E. | 4 | 120 | 50.5 | ....... | .... | 120 | 33.7 | 35.3 | .... | 34.9 | craterlike object east of crater A. |
| | 5 | 129 | 41.8 | 129 | 30.5 | 129 | 28.5 | 29.3 | 29.5 | 29.5 | crater A. |
| | 6 | .... | .... | ....... | .... | 132 | 17.1 | .... | .... | 17.7 | craterlike object on S. E. wall. |
| | 7 | 141 | 40.0 | ....... | .... | 140 | 29.8 | 28.0 | .... | 30.8 | object southwesterly of crater A. Defect in Plate? |
| | 8 | 156 | 20.5 | 156 | 14.7 | 156 | 14.4 | 14.3 | 14.2 | 14.9 | southerly mountain crest on exterior. |
| | 9 | .... | .... | ....... | .... | 162 | 24.3 | .... | .... | 25.2 | defect in plate? |
| | 10 | .... | .... | 165 | 31.0 | 166 | 31.2 | .... | 30.0 | 32.3 | object in mountain mass south of *Archimedes*. |
| S. W. | 11 | .... | .... | 183 | 32.0 | 183 | 30.7 | .... | 31.0 | 31.8 | object in the same mountain mass. |
| | 12 | 210 | 50.0 | ....... | .. | ..... | ..... | 35.0 | .... | .. . | rill χ, southwesterly of *Archimedes*. |
| | 13 | .... | .... | 210–232 | 8 | ..... | ..... | .... | 7.9 | .... | southwesterly wall on interior. |
| | 14 | .... | .... | 235 | 5.1 | ..... | ..... | .... | 4.9 | .... | bright spot in interior. Fault in plate. |
| | 15 | 237 | 20.0 | 236 | 15.5 | ..... | ..... | 14.0 | 15.0 | .... | transverse cañon in S. W. wall. |
| | 16 | .... | .... | 237 | 24.7 | ..... | ..... | .... | 23.9 | .... | ridge southwest of *Archimedes*. Fault in plate? |
| | 17 | 247 | 39.3 | 249 | 24.0 | ..... | ..... | 27.5 | 23.2 | .... | terraced declivity, west of *Archimedes*. |
| | 18 | .... | .... | 250 | 17.6 | ..... | ..... | .... | 17.0 | .... | yokelike connection between westerly wall on exterior and interior. |
| N. W. | 19 | 273 | 37.0 | ....... | .. | 277 | 21.0 | 25.9 | .... | 21.7 | annular ridge west of *Archimedes*. |
| | 20 | 281 | 30.0 | 281 | 21.2 | ..... | ..... | 21.0 | 20.5 | .... | craterlike object on west outer wall. |
| | 21 | .... | .... | ....... | .... | 304 | 34.7 | .... | .... | 35.9 | crater pit. Defect in plate? |
| | 22 | 309 | 41.8 | 309 | 30.5 | 309 | 28.5 | 29.3 | 29.5 | 29.5 | crater C. |
| | 23 | 332 | 36.4 | 333 | 25.7 | 331 | 26.1 | 25.5 | 24.9 | 27.0 | crater d. |

## *Remarks.*

1. This little crater, shown by SCHMIDT, northeast of the Mountain E, with a diameter of about 2.5 kilometres, appears bright on I (like crater *d*, northwest of E) and may perhaps be identical with the little dark speck in the given position on II. There is a better agreement of *p* and *d* in I than in II; it is necessary to observe that on account of libration the first distance is to be increased and the second decreased in order to obtain a reduction to mean libration.

2. The interior northeast wall shows in this area two extensive depressions on II, the northerly having a crater-like appearance; while SCHMIDT has this inner wall entirely separated from the outer, without showing any transverse yoke or saddle.

3. At this point we notice upon I a light finger-shaped appendage (buttress), of the extent of 1½$^{mm}$, by which the

inner wall projects into the floor of *Archimedes*. SCHMIDT has nothing similar.

4. This object, east of crater A, appears on II like a crater pit, and agrees with the most northerly of the small craters there depicted by SCHMIDT.

5. The northwest edge of crater A is not sharply defined upon II. While the diameter of this crater, measured normal to the line of the sun's direction, is nearly $4^{mm}$ on both I and II, this is no longer the case if measured in the direction of the sun, for in that case it becomes 4.7 (reduced 4.5) on I, and 5.2 (reduced $5.4^{mm}$) on II, whereby an uncertainty in the position of the adopted initial point of the co-ordinates of $2.5^{mm}$ is caused.

6. On the southeast wall we have here according to II a nearly circular shallow depression of about $1\frac{1}{2}^{mm}$ diameter, which shows similar characteristics to the object described under (4). SCHMIDT has no indication of it, whereas the little crater shown on his chart on the southeast wall, with $p = 109°$, $d = 25.4^{mm}$, can not be recognized on II.

7. This object on II looks like a crater with a light floor, but it is possible that it may be a fault in the plate, for spots of similar extent, rotundity and intensity appear quite frequently upon the positive plate made at Prague, where their size amounts to $0.1^{mm}$ only, in places where such craters do not occur at all. It may be mentioned that this spot agrees pretty well with the end of the southwesterly valley joining on A as shown by SCHMIDT.

8. At this point the course of the outer crest line of the southwest wall agrees on I and II, but differs from SCHMIDT.

9. Appears to be a faulty little speck in plate II. SCHMIDT shows at this point no crater of any kind.

10. Here we notice upon II, in the mountain mass south of *Archimedes*, a depressed ellipitical plain of $4^{mm}$ extension, containing a central elevation. The position of the latter is designated by the given values of $p$ and $d$. The same elevation is also found on I. The difference in $d$ is fully explained by the effect of libration. This object, having all the *appearance* of a crater-like plateau on a high mountain range, not unlike the basin of a mountain lake, is shown neither by SCHMIDT, MÄDLER, LOHRMANN or NEISON.

11. This object looks on I like a crater formation, which it can not be, however, considering the shadow cast. It represents rather an elevation with an easterly shadow, as readily detected

upon II. Analogous illusions are apparent in several other objects of this plate, south of the one mentioned, but which have not been shown here.

12. Of this known rill nothing certain is recognized on I and II. The cause may lie in the conditions of exposure of the plates.

13. This part of the southwest wall shows on I very sharply notched configurations, which are not found on II. This may lead us to the conclusion that these notches lie deeper than the crest, which is confirmed by SCHMIDT'S drawing of the southwest wall.

14. At this point we notice upon I in the interior of *Archimedes* a bright spot with an apparent easterly shadow. If this object of the plate has a real existence on the moon it would be a most interesting one, for MÄDLER ("The Moon"....) says: "We further remark that MAYER'S small chart of the moon has a bright spot in *Archimedes*, which seems to designate a central mountain. Such an one, however, is known with absolute certainty not to exist here. He probably saw the light central stripe very indistinctly and took it to be a central elevation." As we had no additional photographic plate of the same evening in Prague on hand, the decision of this question was left to Professor HOLDEN, who, after a most careful examination of the plates preserved at the Lick Observatory, expressed himself as against the real existence of this bright spot.

15. This transverse cañon in the southwest wall shown by SCHMIDT is clearly identified on I.

16. This position characterizes on I the centre of a bright ridge casting a shadow, situated southwesterly of *Archimedes*, extending about seven or eight kilometres nearly in the direction of the meridian, which object is entirely missing on SCHMIDT'S chart, for it indicates there a smooth plain. If this be not again a fault of the photographic plate similar to object 14 (which however is hardly probable), the reality of this ridge should become a particularly interesting fact. Nothing certain is discernible thereof on II.

17. This object seen upon I, the centre of which is located by *p* and *d*, makes the impression of a terraced declivity casting a shadow of about ten kilometres, west of *Archimedes*, and may be identical with the elevation shown by SCHMIDT, extending from northeast to southwest.

18. At this point will be noticed a yoke-like connection

between the exterior and interior walls of *Archimedes* in the west. At both sides of the same there are noticeable rifts or ravines of considerable depth. SCHMIDT has no indication of this.

19. Upon SCHMIDT'S chart this annular ridge is shown in the shape of a triangle. On I it is nearer like an oval lying in the direction of the meridian. Position angle and distance of the centres do not agree with sufficient accuracy.

20. This object seems to represent on I a crater-like depression but does not appear as such on SCHMIDT'S representation.

21. On II there is seen at this point something that looks like a sort of a crater-pit of small size, but this object is just as likely to be a defect in the photographic plate.

22. This crater designated by SCHMIDT as C shows upon I an elevated appendage or buttress on the east towards the mountain E, and on II it shows to the north and almost adjoining it a shallow pit. These are not given by SCHMIDT.

23. This crater which SCHMIDT refers to as *d*, appears on I as a bright spot, but upon II as a real crater. The difference in distance between I and II is accounted for by the effect of libration. It might be presumed, judging from the diverse character as indicated by the photographic plates, that only the eastern wall of this crater is of a precipituous nature; while the western wall has a more gentle decline, which would throw a deep easterly shadow only at a lower position of the sun.

Mountain E.—This is interesting on account of the difference in shape on I and II. From it a long ridge reaches toward the southwest, which does not, however, end off as uniformly as SCHMIDT has it. Particularly interesting is the dark crossing of the same, shown on both drawings east of the crater *d*.

Concerning the interior of *Archimedes* it is shown that both photographs do not at all lend it the appearance of the "mirror-like smoothness" of MÄDLER'S plain. In considering its numerous and diverse photographic details, it is of course to be observed that we are not able to separate those that are due to the inequalities of the bottom, from those that find their origin in faults of the plate and in the finer gradations of the sensitive film, so long as there are not at least two consecutively taken plates on hand for comparison. For this reason a discussion of the interior details of *Archimedes* must here be omitted entirely. It may only be mentioned that the well known lighter zones of the floor are quite visible, but that of the finer craters, shown by SCHMIDT and others, nothing is discernible in the interior.

The whole comparison of these photographic representations with SCHMIDT'S chart confirms again the excellence of the latter, but it shows too, that it may be improved upon.

It has also been of great interest to me to compare I and II under the same conditions of light with a view through the 6-inch STEINHEIL refractor of the Prague Observatory. II was compared on the 31st of March of this year, at 16½$^h$ Prague mean time, I on April 17th, this year, at 8½$^h$ Prague mean time with the celestial object. Although at both times the air was rather unsteady and not very clear, so that a magnifying power of only 150 seemed advisable, still it was readily proven to me that the photograph did not represent everything visible. For instance, clear and easily discernible tracings of terraces, on a brightly illuminated background were lost entirely, while in the lesser shaded parts a plentiful and just as easily distinguished detail was lacking altogether. It is possible to explain this only by assuming that the adopted mean period of exposure for the plate, which would furnish the best *average* picture, over-exposes the bright walls of *Archimedes*, and that thus the dark terrace lines thereon are obliterated, as a result of the effect of diffraction of the surrounding light, (compare the photographic representation of a narrow lightning-rod on a background of light clouds, which by exceeding a certain exposure will disappear entirely from the picture) and, on the other hand, shaded portions of the wall are under-exposed in the same manner. It must also be mentioned here that on the 17th of April of this year the crater *d* showed in its interior *another* shadow, whereas the same is entirely lacking on I. In addition to all this we must admit that numerous photographic details were *not* discernible with the telescope.

From the foregoing the conclusion is justified that photographic representations of the moon, as constantly improved upon and now approaching a degree of completeness never before attempted, as at the Lick Observatory, furnish a most valuable aid to optical observation, and will, considering the diversity in the chemical and optical *albedo* of the lunar surface, become the means of materially supplementing it. But it is to be remembered that *one* photograph alone will not give us an absolutely true representation of the moon, meaning a representation of *everything* visible; for with a certain period of exposure some parts will be sure to be over and others under-exposed. It is only by taking a series of consecutive photographs of varying exposures, which should be confined rather to very small lunar areas, that we can finally hope to obtain a copy true to nature. In the same manner in which we succeed in photographing the dark solar spots on the bright face of the sun, we should also be enabled to obtain the dark terraced lines on the lighter walls, heretofore referred to, or the fine black rills surrounded by bright light, if the exposure of the plate be properly reduced. The final decision in this matter, however, will depend upon experiment. Although a photographic representation of the moon, in spite of the most excellent results of the Lick Observatory, leaves much to be desired in point of strength and clearness, as particularly apparent in studying the greater enlargements, it yet furnishes us a wonderfully beautiful relief of considerable expanse, which can *never* be retained and depicted with equal truth to nature by the most skillful draughtsman, on account of the great mass of visible objects and the rapid change of lunar shadows; and at the same time it gives an astonishingly accurate detail of individual portions, which for the control and revision of present lunar charts becomes of the *utmost* value to the selenographer.

PRAGUE, July 6th, 1891.

## NOTE TO PROF. WEINEK'S PAPER, BY EDWARD S. HOLDEN.

This is not the place to say how great an impulse has been given to the study of the moon by the investigations which Professor WEINEK has undertaken upon the Lick Observatory negatives. I desire, however, to say one word, in addition to what has already been said, upon the very important matter of reproducing the negatives, or drawings from the negatives, so that they can be published in large editions. This matter has engaged the attention of Professor WEINEK and myself for about two years. It is comparatively easy to find new features, and old features in new relations, upon our negatives of the moon; and it is easy to show these to any one who can study the original negatives or glass copies of them. It is, however, extremely difficult to reproduce the negatives in a large number of copies, so that any reader can follow a description. The most satisfactory method *theoretically* is to enlarge the original negatives by photography and to make silver prints from the enlarged negatives. This method has not been practicable for various reasons. It is very difficult,